

## CO<sub>2</sub> Laser Surgery for Verrucous Carcinoma of the Larynx

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**Background:** The verrucous carcinoma (VC) is a low grade malignant tumor. Treatment strategies of VC of the larynx are topics of the ongoing discussion, and the role of the carbon dioxide laser therapy in the management remains unclear to date.

**Study Design/Materials and Methods:** From 1986 to 1995, 21 patients with glottic VC were treated with transoral carbon dioxide laser surgery. Follow-up ranged from 6 to 122 months (mean 52).

**Results:** In T1 lesions, a complete removal of the tumor was possible with laser-cordectomy in ten cases and with extended laser cordectomy in four cases. In seven patients suffering from T2 carcinoma, a partial laser laryngectomy was performed. There was no tumor-related death in this series. No patient required laryngectomy or radiotherapy.

**Conclusion:** The results presented here are superior to those previously reported with radiotherapy. They add further support to the observation that surgery is the better treatment option for VC of the larynx. Based on the results of this study, recommended treatment for T1 and T2 VC is oncologic CO<sub>2</sub> laser surgery in combination with a meticulous follow up for early recognition of local recurrence. *Lasers Surg. Med.* 21:117–123, 1997. © 1997 Wiley-Liss, Inc.

**Key words:** Ackerman's tumor; complications; conventional surgery; radiotherapy; transoral laser surgery

### INTRODUCTION

The term "verrucous carcinoma" (VC) was first introduced in 1948 by Ackerman [1]. This tumor is a highly differentiated variant of the squamous cell carcinoma that may develop in any mucosal surface. The glottic region of the larynx is the preferential location in the upper airways [2]. The incidence of these uncommon malignant lesions accounts for ~1–3.8% of all laryngeal carcinomas [3,4].

Histologic examinations show pronounced acanthosis, hyperkeratosis, pushing borders with a surrounding inflammatory reaction, and the absence of atypical nuclei or dysplastic cells [5]. Based on microscopic findings, difficulties are encountered in separating verrucous carcinomas from papilloma, pseudoepitheliomatous hyperpla-

sia, verrucous hyperplasia, and highly differentiated squamous cell carcinoma with a verrucous appearance. Immunohistological investigations have support the hypothesis that VC are of viral etiology [6]. Clinically, the tumor has a warty papillomatous appearance, is growing slowly, locally invasive and is not supposed to metastasize [7]. The verrucous carcinoma have accordingly been treated by radiotherapy or surgical procedures [8]. The aspect that has received most attention is the high risk for local recurrence and anaplastic transformation following irradiation or surgery as well [9,10]. Management strategies of

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**TABLE 1. Verrucous Carcinoma of the Larynx: Clinical Data and Outcome of 21 Patients Treated With Laser Surgery**

No.	Age <sup>a</sup> (years)	Sex	Glottic site	Tumor Stage (UICC) <sup>b</sup>	Type of initial laser resection	Number of micro- laryngoscopic controls	Follow- up time (month)	Second primary, complications, other observations	Outcome <sup>c</sup>
1	63	m	right	T1b	III	8	122	bronchial carcinoma pT2N1M1 9/94	AFD
2	52	m	right	T2	IV	2	118		AFD
3	41	m	right	T2	IV	3	116	tracheostomy	AFD
4	50	m	bilateral	T2	IV	4	113	tracheostomy, glottic stenosis	AFD
5	50	m	left	T1a	II	2	80		AFD
6	68	m	right	T1b	III	2	76		DID
7	46	m	right	T1a	II	3	75		AFD
8	63	m	left	T1a	II	2	75		AFD
9	69	f	right	T1a	III	1	69		AFD
10	79	m	bilateral	T2	IV	2	61		DID
11	54	m	left	T1a	II	2	50	bronchial carcinoma pT1N1MX 6/94	AFD
12	45	m	left	T1a	II	4	23	recurrence on contralateral vocal cord, salvage therapy: laser type II	AFD
13	65	m	left	T1b	II	3	23	extended laser type III resection performed for residual disease	AFD
14	61	m	right	T1a	II	2	22		AFD
15	74	m	bilateral	T2	IV	2	16	neck dissection	AFD
16	55	m	right	T2	IV	1	15	extended laser resection for residual disease, postoperative palsy of the hypoglossus nerve	AFD
17	50	m	right	T1a	II	2	14		AFD
18	72	m	right	T1a	II	2	14	lost to follow up	AFD
19	51	m	right	T1a	III	2	8		AFD
20	61	m	right	T1a	II	2	6		AFD
21	66	m	bilateral	T2	IV	2	6	aspiration pneumonia	AFD

<sup>a</sup>At time of the diagnosis.<sup>b</sup>Union International Contre le Cancer [23].<sup>c</sup>AFD-alive and free of disease; DID-died of intercurrent disease.

these neoplasm are topics of ongoing discussion. The literature favors the surgical treatment of VC. The role of the carbon dioxide (CO<sub>2</sub>) laser therapy in the management remains unclear to date.

The purpose of the present study was to evaluate the results of CO<sub>2</sub> laser surgery for the treatment of VC of the larynx at the authors' institutions, to compare these data with those reported in the recent literature concerning radiation and conventional surgical approaches, and to establish indications for laser surgery in this laryngeal lesion.

## MATERIALS AND METHODS

The department's tumor registry was reviewed to identify those patients that presented with VC of the larynx from 1986 to 1995. The histologic material of 32 tumors was retrieved, reviewed, and classified irrespective of initial di-

agnosis in all cases, adhering to the diagnostic criteria laid down by Ackerman [1], Kraus [11], and Ferlito [4,12]. Twenty-one patients presented with glottic primaries fulfilling these diagnostic criteria and were included in this series. These patients were all treated with transoral laser surgery. All charts could be retrieved, containing detailed data of tumor staging, therapy, and outcome for retrospective analysis. The clinical data of these 21 patients are shown in Table 1.

One patient presented with a T4N0M0 supraglottic VC and was treated with total laryngectomy. The histology of the remaining ten tumors did not fulfil the criteria of VC. These 11 cases were excluded from our series.

## Surgical Technique

The working beam of the carbon dioxide laser (Hereus Laser Sonics LS 500) was coupled to the operating microscope by a visible coaxial he-

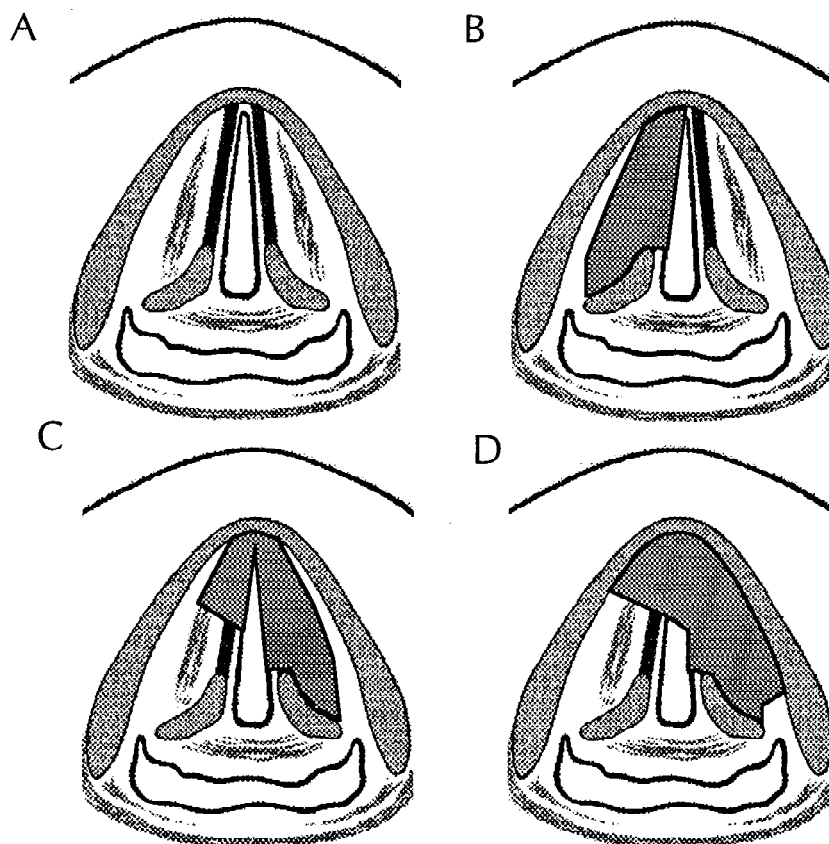


Fig. 1. Types of laser resection. The hatched areas represent the extension of endolaryngeal resection. **A.** Normal larynx, horizontal view on the glottis. **B.** Type II resection: laser cordectomy. **C.** Type III resection: extended cordectomy. **D.** Type IV resection: endolaryngeal exenteration.

Type I resection not depicted, since none of the patients in our study had this procedure.

lium-neon laser and using a micromanipulator on the laser delivery head. After a biopsy, the laser was used as a "light scalpel" to excise a lesion with appropriate margins as an en bloc resection suitable for histologic examination of the margins.

Transoral procedures for the treatment of glottic carcinoma are currently subgrouped into the following four different categories at our institution:

**Type I resection.** In a tumor in situ, a type I excision is performed to resect the vocal cord mucosa, leaving the muscle intact. (This type of resection is used for carcinoma in situ and was not applied to any of the patients in this series.)

**Type II resection.** In T1a carcinoma, one vocal cord is resected completely, leaving the anterior third of the other vocal cord and the aryte-

noid intact. The resection equals a conventional cordectomy in extent of excision (Fig. 1B).

**Type III resection.** A T1b tumor is managed by extended cordectomy, including the anterior commissure down to the thyroid cartilage, the subglottic region including the cricothyroid membrane, and the upper margin of the cricoid cartilage as a border. The extension of the enbloc excision reaches up to the arytenoid cartilage and can even include it with preservation of the posterior mucosa (Fig. 1C).

**Type IV resection.** A T2 tumor requires a type IV resection (laryngeal exenteration) containing all the endolaryngeal structures down to the thyroid and cricoid cartilage and down to the cricothyroid membrane as well as to the arytenoid cartilage, which can be included on one side (Fig. 1D). The excision can be extended farther in the

craniocaudal direction than conventional frontolateral partial laryngectomy, whereas the cartilaginous framework is left intact.

Types III and IV resections may include an arytenoidectomy of one side if the extension of the tumor requires it and may be performed unilaterally or bilaterally. The resected specimen is mounted to a cork plate and anatomically marked according to the excision area for pathologic and histologic investigation.

Microlaryngoscopic examination under general anesthesia with multiple biopsies are performed 6 and 12 weeks after the resection. Later on, laryngoscopy with a 90° zoom endoscopes, chest X-rays, and sonography of the neck are carried out.

## RESULTS

### Demographic Data

These 21 cases of verrucous carcinoma represent 2.7% of 785 primary larynx cancers (all sites) diagnosed at the authors' institutions during the observation period. The VC involved 20 men and one woman, ranging in age from 41 to 79 years (mean 57.4 years). Eighteen (85%) had a history of smoking >20 cigarettes per day. Follow-up ranged from 6 to 122 months with a mean duration of 52 months.

### Staging, Diagnosis, and Treatment

All patients had glottic primaries. Fourteen were classified T1 and seven T2. Preoperative neck sonography revealed enlarged cervical lymph nodes (size >1 cm) in seven patients. The first endoscopic biopsy allowed no proper histologic diagnosis in eight patients. In four of these patients, a second microlaryngoscopic biopsy was diagnostic. In the remaining cases, the complete lesion was removed with a laser resection as an excisional biopsy, allowing for the establishment of the final diagnosis. Transoral laser cordectomy or laser partial laryngectomy was the initial treatment modality in all lesions. A complete removal of the tumor during the first intervention was possible in 19 patients. However, the histological examination of the specimen indicated residual tumor in patients 13 (anterior commissure) and 16 (contralateral vocal cord). After extended laser excision, both patients were free of disease. Tracheostomy was performed in patient 3 because of threatening airway obstruction and in patient 4 during the laser partial laryngectomy to secure

the airway from a swelling of the adjacent tissues. Neck dissection was performed only in patient 15 without evidence of lymph node metastases. No postoperative radiation therapy was given to any of the patients.

### Postoperative Healing Process and Complications

Re-epithelisation of the nonclosed surgical defects was complete within 3–6 weeks after transoral surgery, depending considerably on the size of the surgical defect. All patients were advised to resume their diet on the first postoperative day. Patient 21 suffered from prolonged dysphagia with recurrent aspiration and was hospitalized 8 weeks after the initial intervention with aspiration pneumonia. Intravenous antibiotic therapy was administered in combination with an intensive training for swallowing. The laryngeal function improved, allowing the discharge with oral diet after 2 weeks. Patient 16 presented a temporary palsy of the left hypoglossus nerve (neurapraxia) postoperatively. Patient 3 developed a glottic-supraglottic stenosis, requiring further surgical treatment.

### Follow-up, Local and Regional Control

Follow-up revealed 18 patients to be alive and free of disease from 6–122 months following initial laser surgery. Only one patient (12) had recurrence on the contralateral vocal cord, requiring further transoral laser surgery. He has since remained free of recurrence for 15 months. Two patients (6 and 10) died of intercurrent disease without local recurrence 6 years and 5 years after surgery, respectively. Patient 18 underwent type II resection in 1990 and was lost to follow-up after 14 months. No patient required laryngectomy or radiation therapy for recurrence. No cases of anaplastic transformation were recognized. Two patients (1,11) developed second primary malignancies (bronchogenic carcinoma) without evidence of local recurrence. There were no tumor related deaths in this series.

Tumor sites, initial treatment, and follow-up data are condensed in Table 1.

## DISCUSSION

From 1986 onward, >300 patients have been treated for laryngeal cancer by transoral laser surgery at the department of otorhinolaryngology of the University of Cologne [13]. The incidence of VC in our patients was similar to that quoted in

**TABLE 2. Verrucous Carcinoma of the Larynx: Results of Radiotherapy and Conventional Surgery in the Literature\***

Authors	Billert et al. [24]	Rayn et al. [17]	Myers et al. [18]	Ferlito and Recher [12]	Abramson et al. [6]	Edstrom et al. [9]	Lee et al. [3]	Lundgren et al. [2] <sup>d</sup>	Hagen et al. [8]
Year	1971	1977	1980	1980	1985	1987	1988	1986	1993
Total number [n]	15	20	7	77	5	6	4	44	12
Follow-up time	>3y <sup>a</sup>	15m–9y	3–13y	1–24y	1–7y	2m–5y	1–6a	6m–20y	3–12y
TMN classification	ND	ND	ND	ND	ND	ND	ND	yes	yes
Radiotherapy [n]	0	3	0	7 <sup>b</sup>	0	6	0	28	2
Initial failure/recurrence		100%		50%		50%		46%	50%
Salvage therapy		2TL,1PL		1PL,1LE, 1TL		1TL		3LE,2PL, 8TL	0
Local control including salvage		100%		86%		67%		89%	50%
Died of disease		0		1 (14%)		2 (33%)		1 (4%)	1 (50%)
Larynx lost		2 (67%)		1 (14%)		1 (17%)		8 (29%)	0
Conventional surgery [n]	15	17	7	60	4	0	4	16	7
Local excision (LE)	0	7	0	10	1		0	2	0
Partial laryngectomy (PL)	10	9	7	34	0		0	9	4
Total laryngectomy (TL)	5	1	1	15	0		0	5	3
Initial failure/recurrence	2 (14%) <sup>a</sup>	2 (12%)	0	4 (7%) <sup>c</sup>	4 (100%)		1 (25%)	0	2 (29%)
Salvage therapy	0	1PL,1TL	0	1LE,1TL, 2PL 1TL	2CO <sub>2</sub> ,1PL, 1TL		1 PL	0	1CO <sub>2</sub> , 1TL+RT
Local control including salvage	86% <sup>a</sup>	100%	100%	97% <sup>c</sup>	100%		100%	100%	90%
Died of disease	1 (7%)	0	0	1 (2%)	0		0	0	1 (8%)
Larynx lost	6 (40%) <sup>a</sup>	2 (12%)	1 (14%)	16 (27%)	1 (20%)		0	5 (16%)	4 (33%)

<sup>a</sup>Eight patients followed up for <3 years.<sup>b</sup>Six patients treated with surgery and radiotherapy; one lost to follow-up.<sup>c</sup>Postoperative course unknown in six patients.<sup>d</sup>This study includes 18 patients previously reported in the series of van Nostrad et al. [14] and Burns et al. [16].\*Abbreviations: m = months; y = years; ND = not done; LE = local excision; PL = partial laryngectomy; TL = total laryngectomy; CO<sub>2</sub> = carbon dioxide laser surgery; RT = radiotherapy.

the recent literature [3,14]. Like others before us, we found an association of this lesion with elderly men, tobacco exposure [6,7], and with second primaries [2,11,15]. Laryngeal VC were predominately diagnosed at an early tumor stage [2,4,6,12,14,16]. These findings are consistent with our data presented here. Re-examination of histologic material frequently reveals that up to 50% of original diagnosis did not fulfil the criteria laid down by Ackerman [1,17].

The outcome of 139 patients treated with surgery and of 46 patients treated with radiotherapy recently reported in the literature is summarised in Tables 2 and 3. The primary control rates are 96% with surgery and 87% with radiotherapy (including salvage) overall in laryngeal VC. Surgery is favored for the treatment of this lesion because of high initial failure rates of radiation therapy (50%) [8,10]. However, treatment of VC continues to be the subject of major controversy. First, tumor classifications are lacking in

the majority of series [3,6,12,17,18], limiting the comparability of previous results with our data. Second, surgical procedures performed in these patients are not uniform. All except nine patients (data reported in five series to 6,8,19–21) were treated with conventional surgery. Some authors prefer radical surgery for VC, e.g., partial laryngectomy in T1 and total laryngectomy in T2 lesions [2,14,16]. Others advocate more conservative treatment strategies, such as local excision, vocal cord stripping or tumor vaporisation in T1, cordectomy for T2 tumors, and total laryngectomy or radiotherapy in very extensive lesions [3,6]. A third group of authors use heterogeneous treatment strategies [8,12]. The special feature of this tumor, i.e., that it appears clinically malignant but histologically benign, may be the reason for the lack of uniformity of therapeutic approaches.

The initial failure rates and the local control rates of different surgical procedures are reviewed and summarized in Table 4, irrespective of



**TABLE 3. Results of CO<sub>2</sub> Laser Surgery: Review of the Literature and Own Data\***

Authors	Grossenbacher [19]	Abramson et al. [6]	Milford and Flynn [20]	Hagen et al. [8]	Abdullah and van Hasselt [21]	This series
Numbers of patients	2 <sup>a</sup>	1	1	3	1	21
Year	1982	1985	1991	1993	1995	1996
Follow-up time	3–4y	1–7y	2–15y	3–12y	3y	6m–122m
TMN classification	T1N0M0: 2	ND	ND	T1N0M0: 3	ND	T1N0M0: 14 T2N0M0: 7
Method						
Local excision (LE)	0	1	1	3	1	0
Corpectomy (CE)	0	0	0	0	0	10
Partial laryngectomy (PL)	2	0	0	0	0	11
Local recurrence	0	1 (20%)	0	1 (33%)	0	1 (5%)
Salvage therapy	0	1 CO <sub>2</sub>	0	1 CO <sub>2</sub>	0	1 CO <sub>2</sub>
Local control with salvage	100%	100%	100%	100%	100%	100%
Died to related causes	0	0	0	0	0	0
Died to unrelated causes	0	0	0	1	0	2

\*Abbreviations: m = months; y = years; LE = local excision; CE = corpectomy; PL = partial laryngectomy; CO<sub>2</sub> = carbon dioxide laser surgery; ND = not done.

<sup>a</sup>Only two of 15 tumors were VC.

**TABLE 4. Local Control and Initial Failure After Surgical Treatment of 150 Patients With VC\***

Treatment method	Numbers	Initial failure	Larynx lost	Died of disease
Non oncologic therapy <sup>a</sup>	28	10 (36%)	2 (7%)	2
Corpectomy	43	4 (9%)	2 (5%)	1
Partial laryngectomy	50	1 (2%)	1 (2%)	0
Total laryngectomy	29	1 (3,5%)	29 (100%)	1

\*Data accumulated from the literature [2,3,6,8,12,17–21,24] and own observations.

<sup>a</sup>Results summarized from local excision, vaporisation, and vocal cord stripping.

missing tumor classifications. Most remarkable finding is the high initial failure rate (36%) of nononcologic surgical methods (local excision or vocal cord stripping) in limited cord lesions, requiring total laryngectomy in 6% for salvage. Although treatment results with corpectomy (initial failure 9%) and partial laryngectomy (2%) are much better, several authors concluded that early VC may be treated like benign laryngeal lesions [3,8]. However, based on our material, T1 and T2 VC of the larynx are best handled by oncologic surgery. CO<sub>2</sub> laser corpectomy or partial laryngectomy has been used in our series successfully to treat VC of the larynx. Only one patient treated in this fashion suffered local recurrence, requiring further surgical therapy. No larynx was lost.

Although we have no personal experience with the use of KTP laser for VC, a recent report indicates that this laser may be even better suited for the microlaryngoscopic treatment of this condition [22]. The CO<sub>2</sub> laser has been the instrument of choice at the authors' institution for T1 and T2 lesions. The benefits of carbon laser excision have been related to the precise application,

to minimal tissue damage of surgical trauma, and to rapid healing [13,22]. Three patients (14%) in our series suffered temporary postoperative complications (see Table 1). Operative treatment should not include neck dissection, even though enlarged lymph nodes may be palpated or detected during sonography [2,8]. In our series, all patients except for one were followed up with neck sonography, revealing no progression of disease.

Multiples biopsies are frequently necessary to establish the diagnosis of VC [2,18]. Biopsy specimens did not suffice for a proper diagnosis in 40% of our patients. The diagnosis of this low grade neoplasm requires large pieces of tissue, allowing the pathologist to examine the deeper layers of the specimen better to understand the relationship between epithelium and the underlining stoma [7,12]. Therefore, the complete lesion was removed by transoral CO<sub>2</sub> laser surgery in four cases after initially unsuccessful histologic examination. This procedure allowed for the establishment of the final diagnosis and was therapeutic at the same time.

Similar difficulties may be encountered in

the postoperative follow-up of VC. The anatomical result after laser resection will be scar formations that replace vocal cord mucosa. Five of our patients required more than two microlaryngoscopic re-assessments to prove local control. The absence of malignant histologic signs hamper the early recognition of recurrence. However, successful management requires long-term meticulous follow-up, best performed at the institution of initial treatment, ensured by close cooperation between surgeon and pathologist.

## CONCLUSION

Transoral laser resection is highly effective for the treatment of T1 and T2 VC of the larynx. Local control rates are comparable to those reported after conventional partial laryngectomies and superior to those after radiotherapy. These findings support a surgical approach. The prognosis of the neoplasm is excellent when adequate treatment is adopted from the beginning. Carbon dioxide laser resection is the method of choice in T1 and T2 VC of the larynx to minimize tissue trauma and local recurrence. For T3 to T4 lesions, the recommendation is total laryngectomy. Neck dissection is not indicated.

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